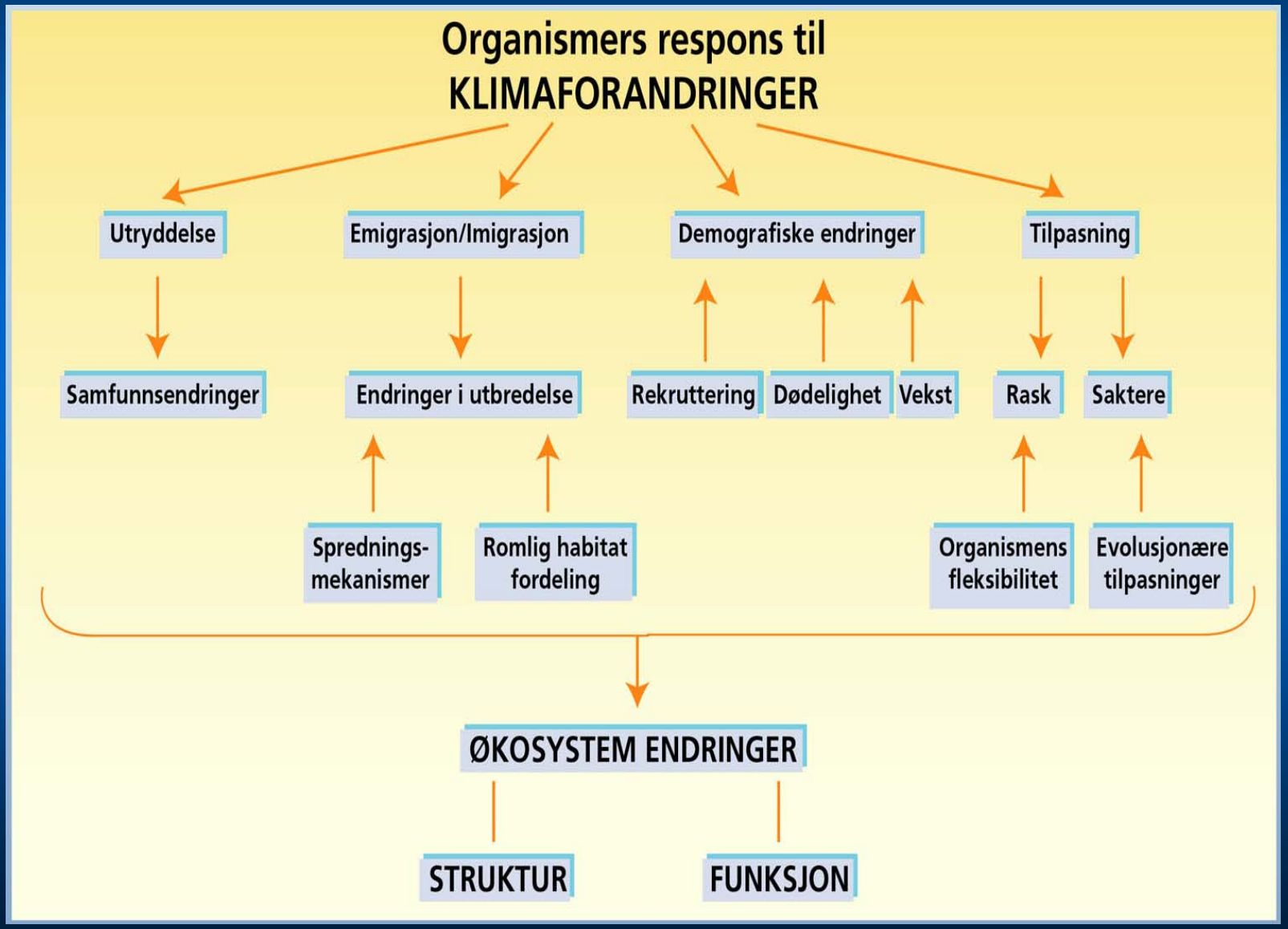
Ferskvann og klima



Ulike responser til klimaendringer



Viktige miljøparametre

Direkte:

Temperatur
Vannføring/ vannstand
Sesonglengde
Isdekke
Snø

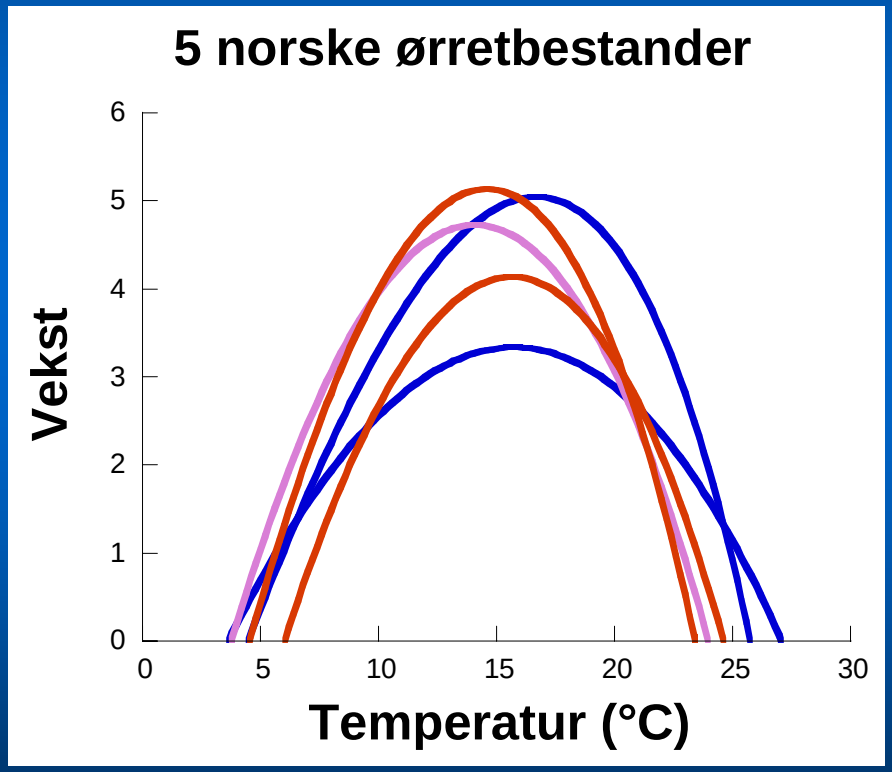
Indirekte :

Endringer i nedbørsfelt
Arealbruk
Vannbruk
Økologiske interaksjoner (konkurranse, predasjon, sykdom)

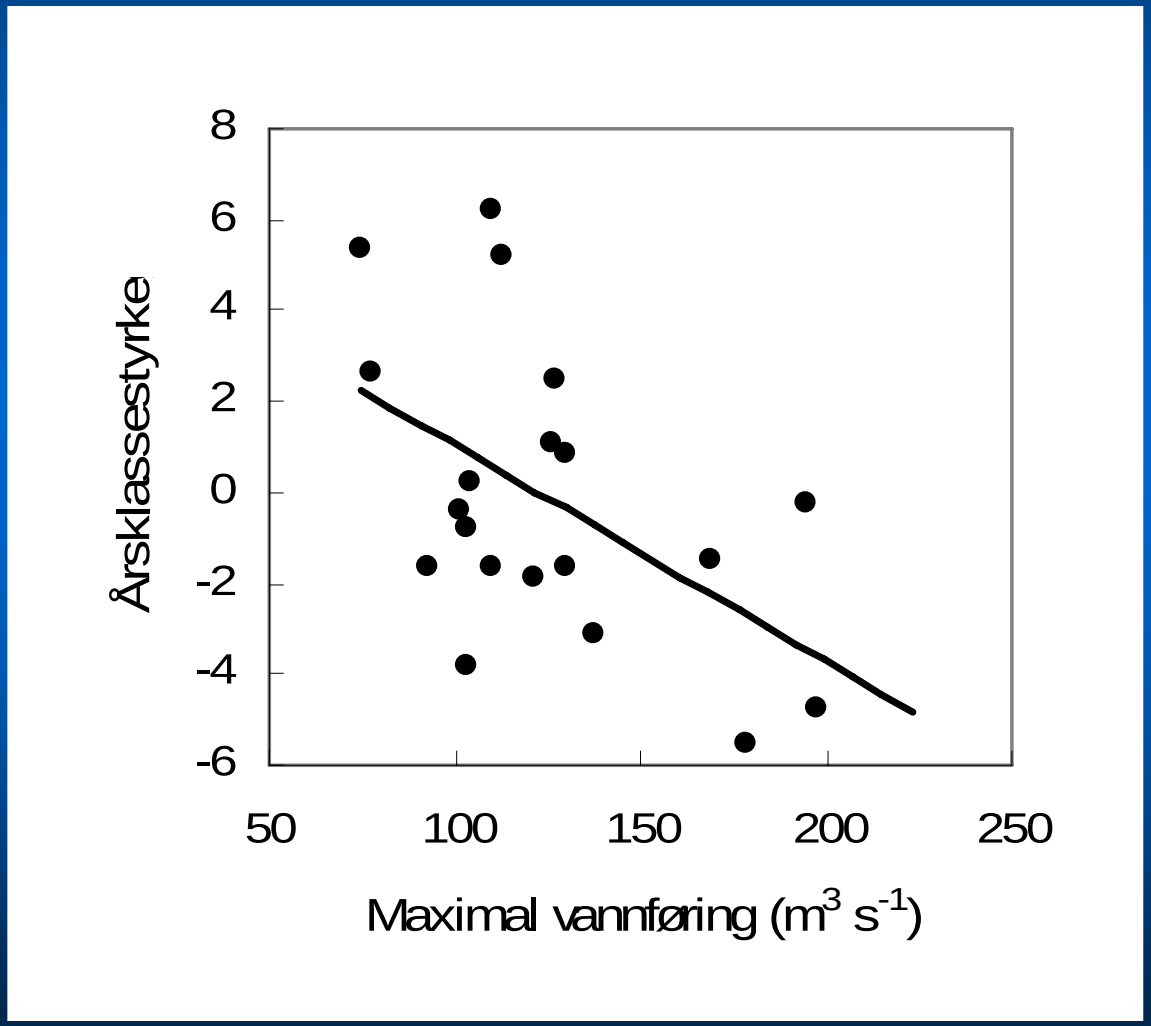
Metodiske tilnærming

- Feltbaserte klimakonvolutter
- Korrelative studier i dagens klima (inklusive gradientstudier)
- Historiske studier (f. eks. bunnsedimenter)
- Laboratoristudier for etablering toleranse- og prestasjonskurver
- Funksjonelle studier (oftest eksperimentelle)
- "Naturlige eksperimenter"
- Storskala manipulative studier (f. eks CLIMEX, THERMOS)
- Modellering

Temperatur

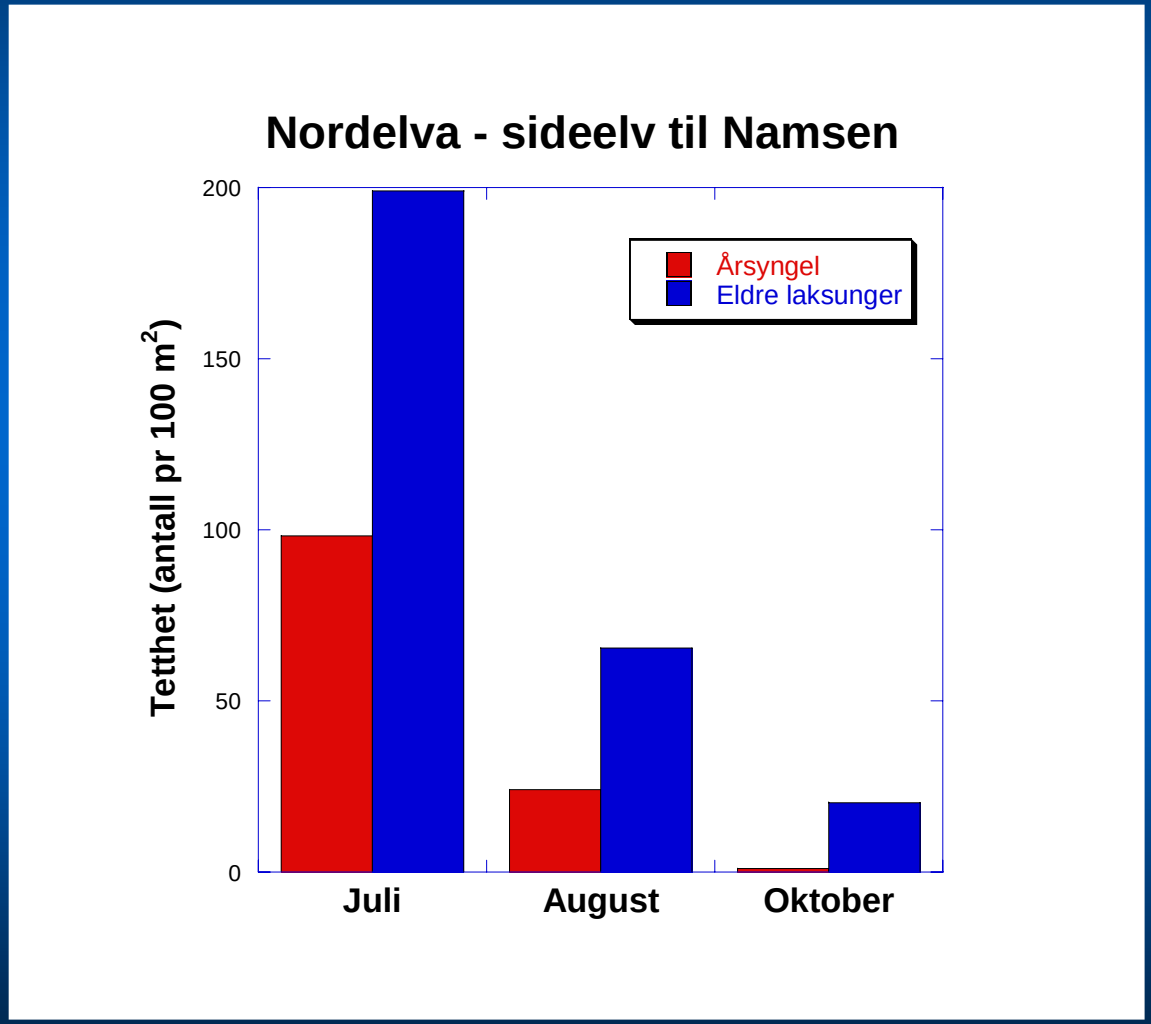

5 norske ørretbestander
Vekst
0
1
2
3
4
5
6
0
5
10
15
20
25
30
Temperatur (°C)

Ekstremvær - flom

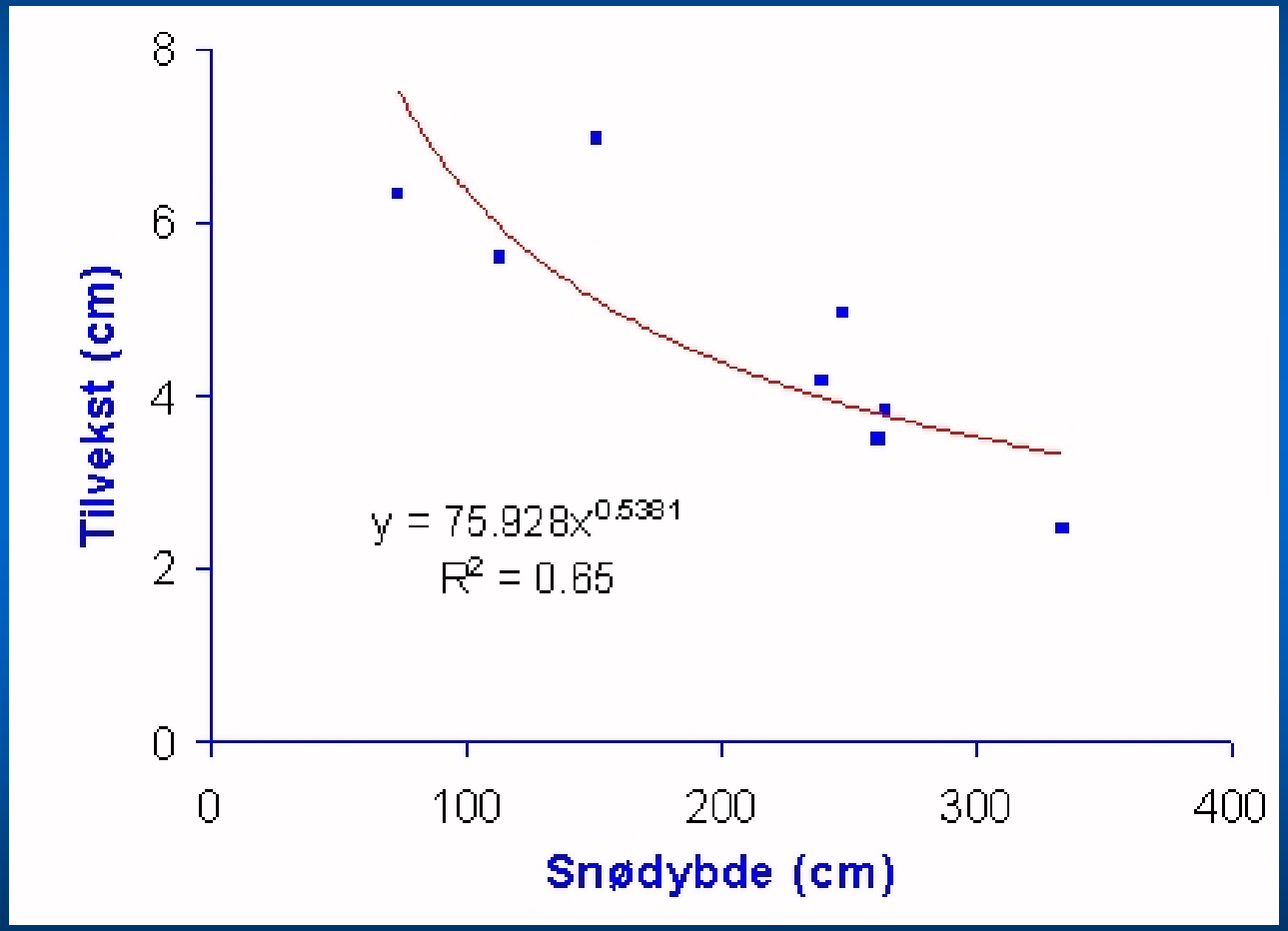


Jensen & Johnsen 1999

Ekstremvær - tørke

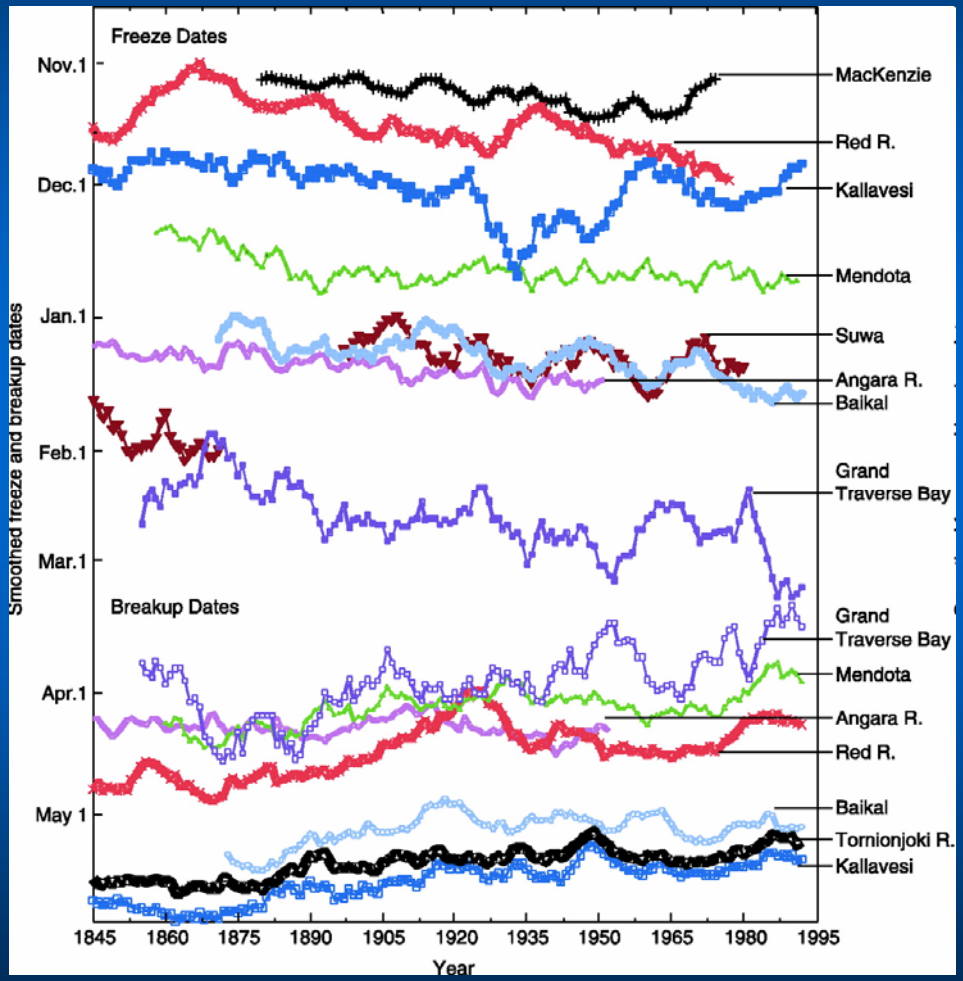


Snø

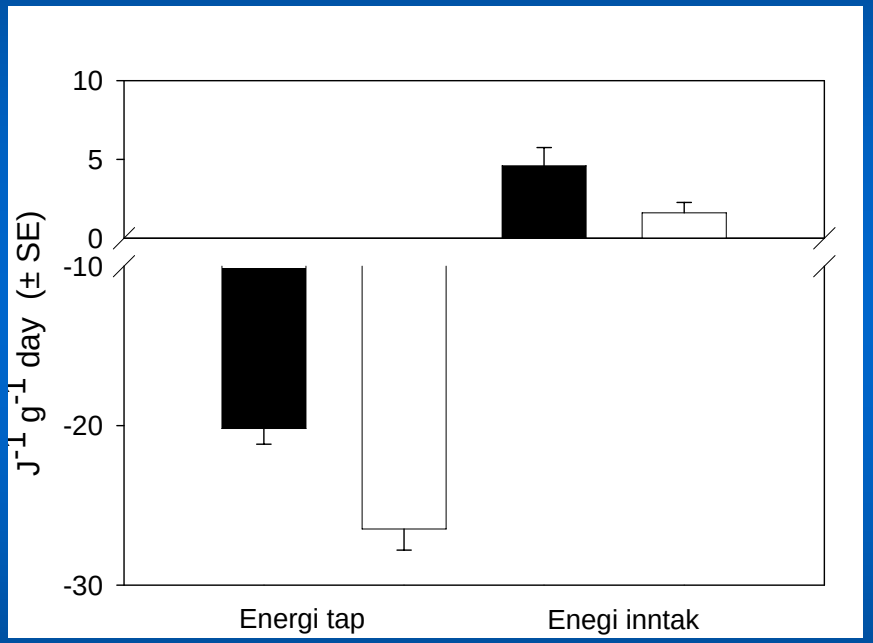


Borgstrøm 2001

Isdekke



Magnuson m.fl. 2000



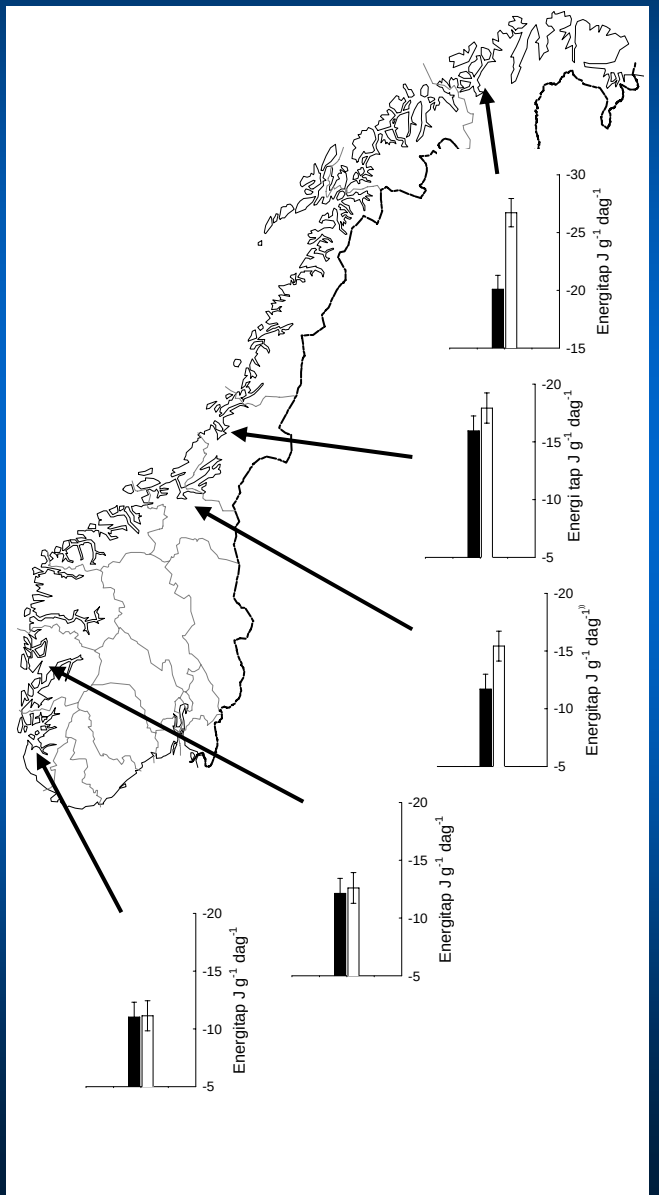
Finstad m.fl. 2000

Viktige utfordringer

- Integrering av økologisk klimateori og evolusjonær teori
- Flerfaglig tilnærming

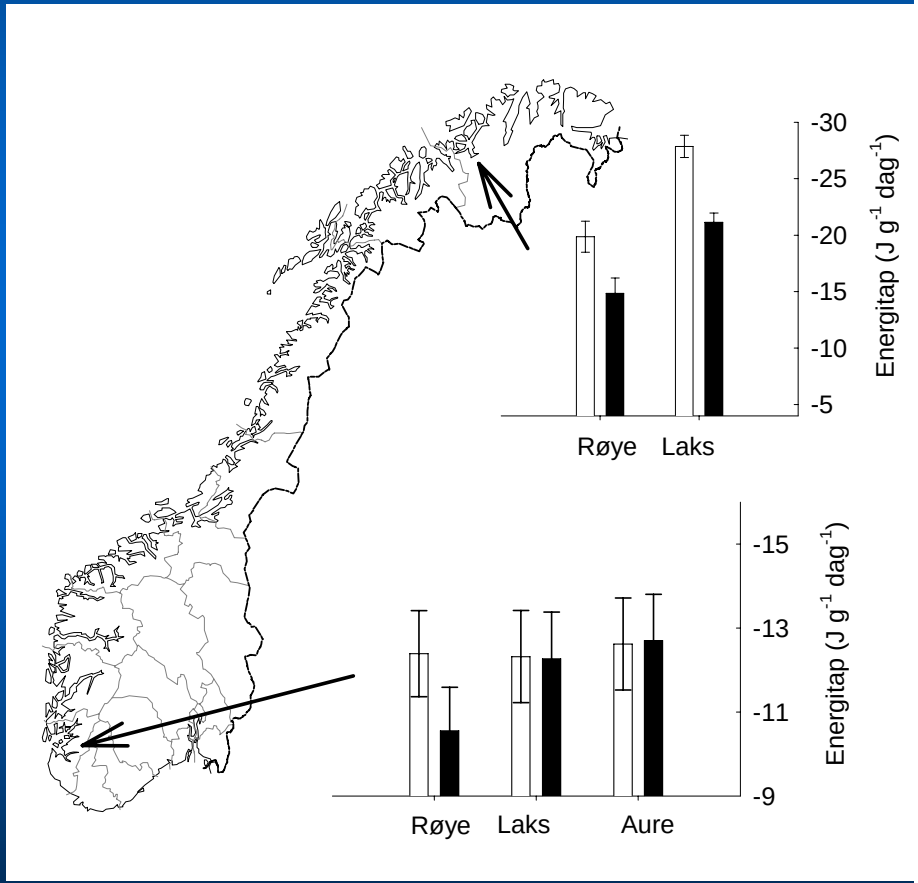
Genetisk adaptasjon

- **Lokale tilpasninger til isdekke (laks)**



Forskjell i tilpasningsevne

- Forskjellige arter kan ha ulik grad av lokale tilpasninger
- Røye kan være mindre evolusjonær fleksibel enn laks

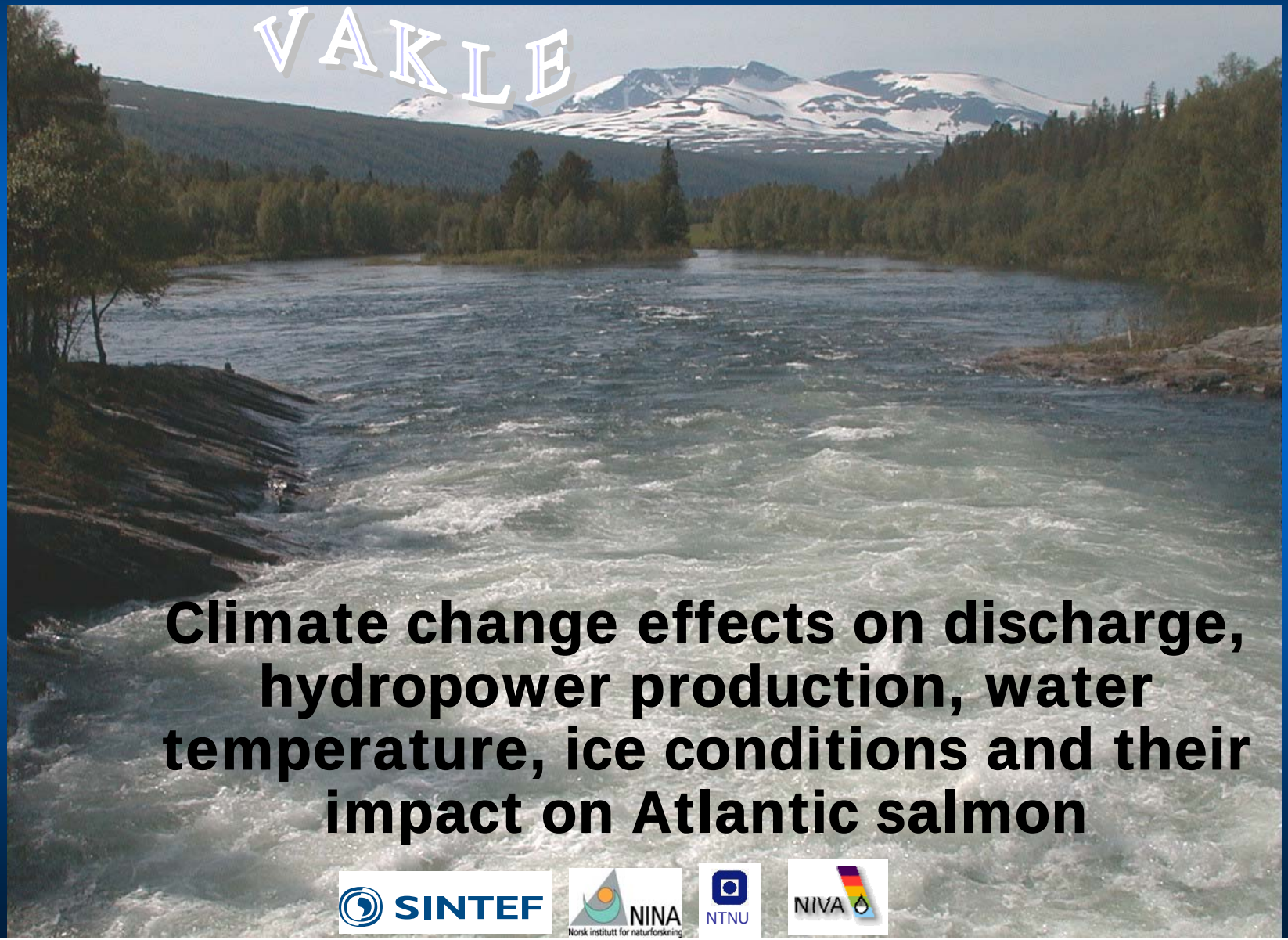


- Vi må kartlegge adaptiv variasjon mellom bestander hos flere arter
- Vi må estimere evolusjonær rate
- Vi må forstå interaksjoner mellom arter i forhold til termale nisjer

Flerfaglighet

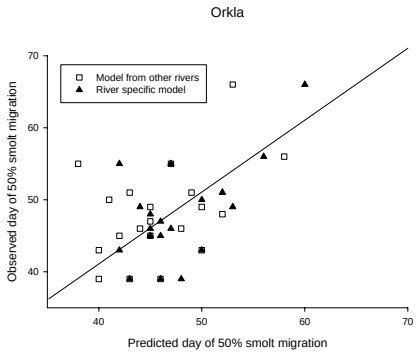
- Samfunn virker på økologi og økologi virker på samfunn
- Vi kan påvirke klimaeffekter

Eksempel på flerfaglighet

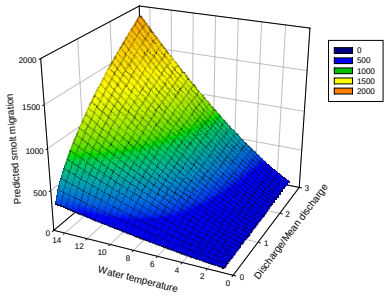


Metodisk tilnærming

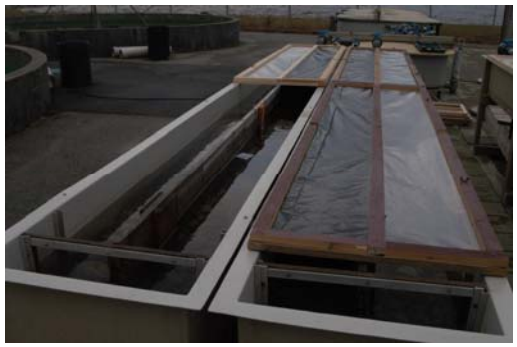
Improve existing models



Building new models and relationships







Experimental studies

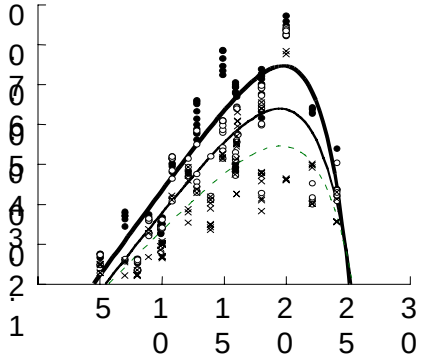


Field studies

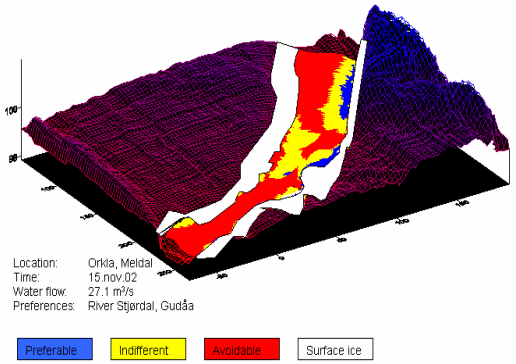
Apply to Orkla

Climate, water temperature, flow conditions

Fish growth



Habitat conditions

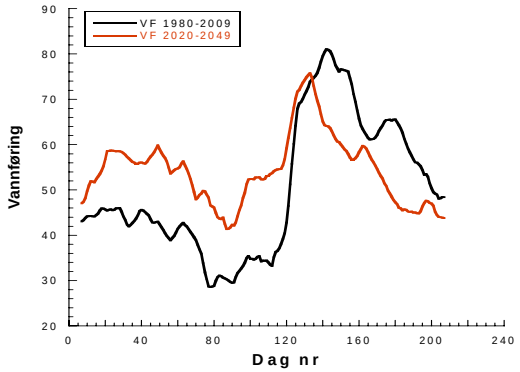


Orkla salmon





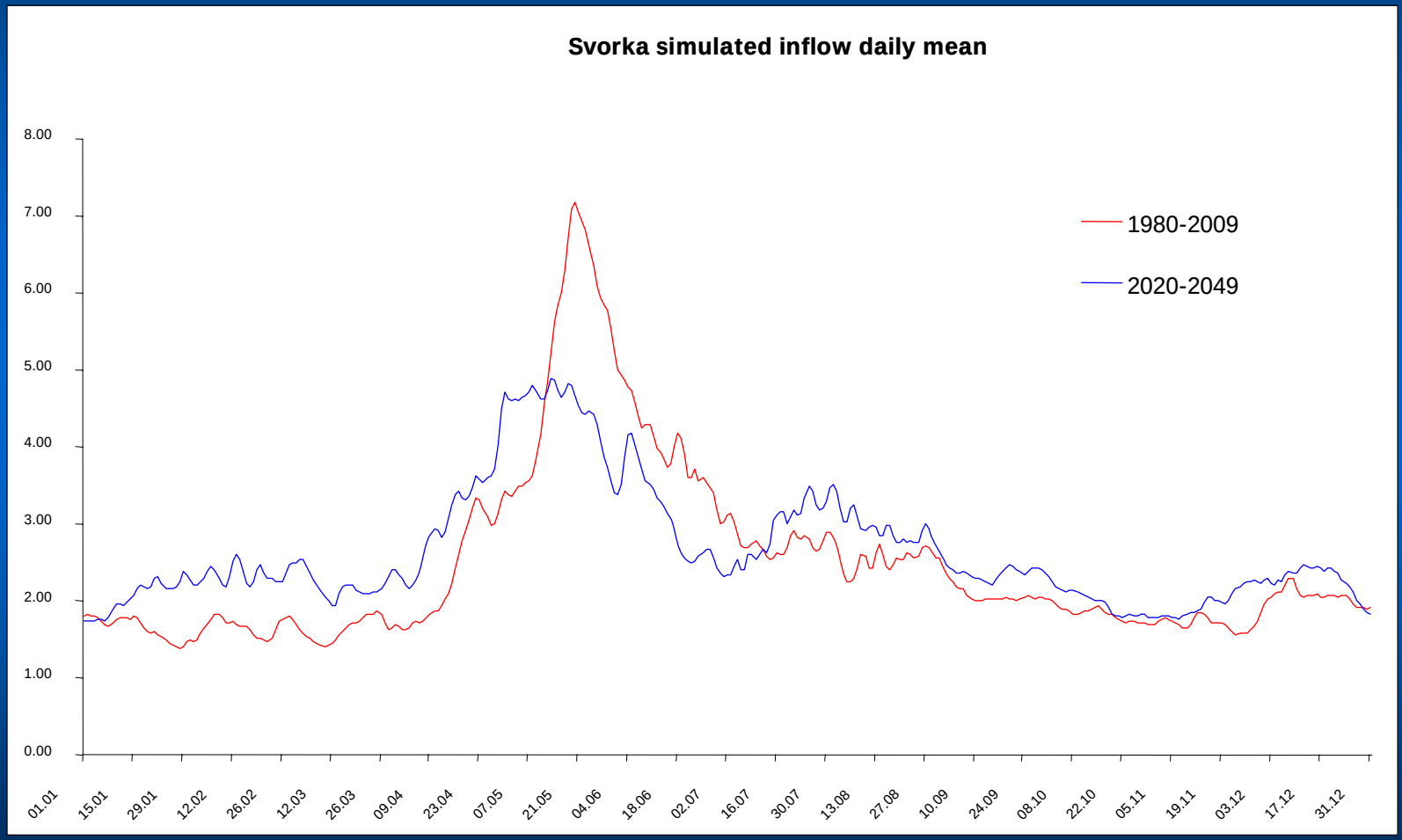
Winter energetics



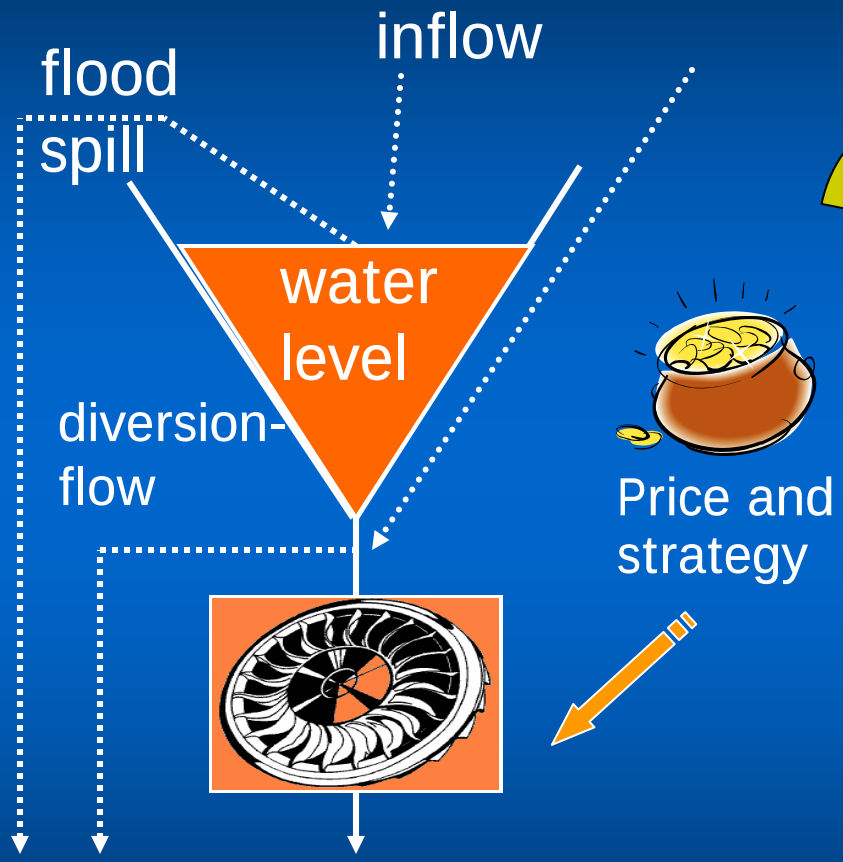
Smolt migration

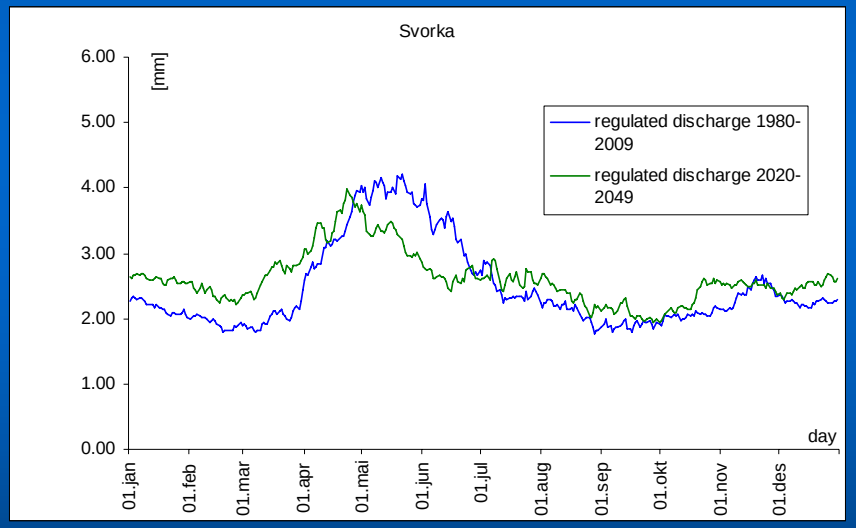
Total effect

Avrenning


Svorka simulated inflow daily mean
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
01.01
15.01
29.01
12.02
26.02
12.03
26.03
09.04
23.04
07.05
21.05
04.06
18.06
02.07
16.07
30.07
13.08
27.08
10.09
24.09
08.10
22.10
05.11
19.11
03.12
17.12
31.12
1980-2009
2020-2049

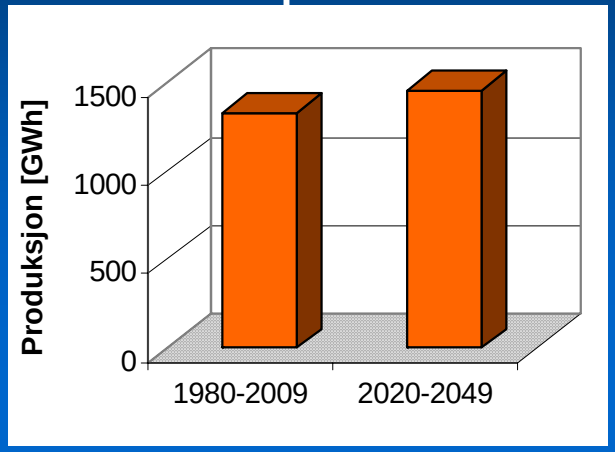
Kraftproduksjonsmodeller



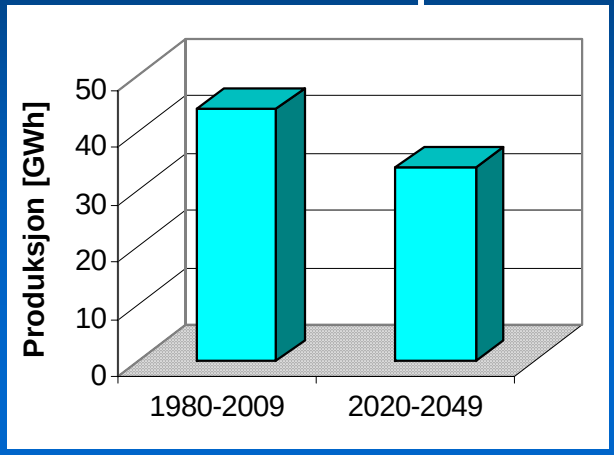


Regulated discharge

Power production



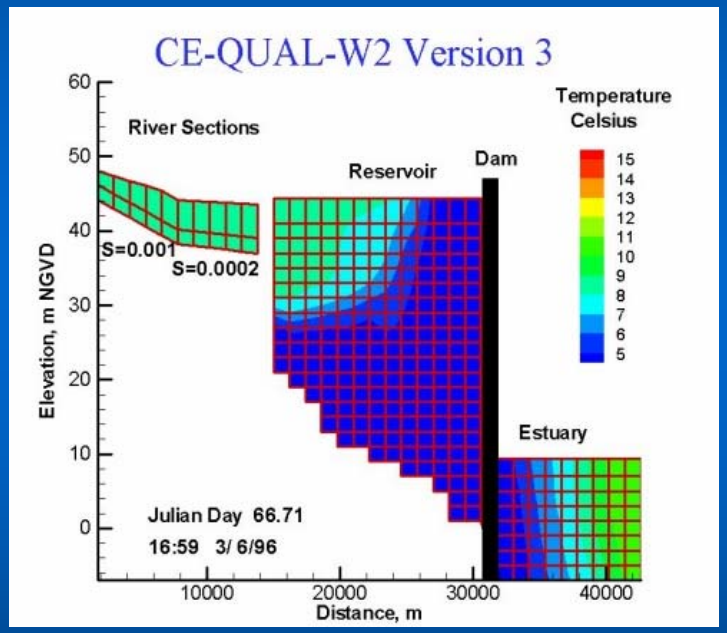
Flood spill

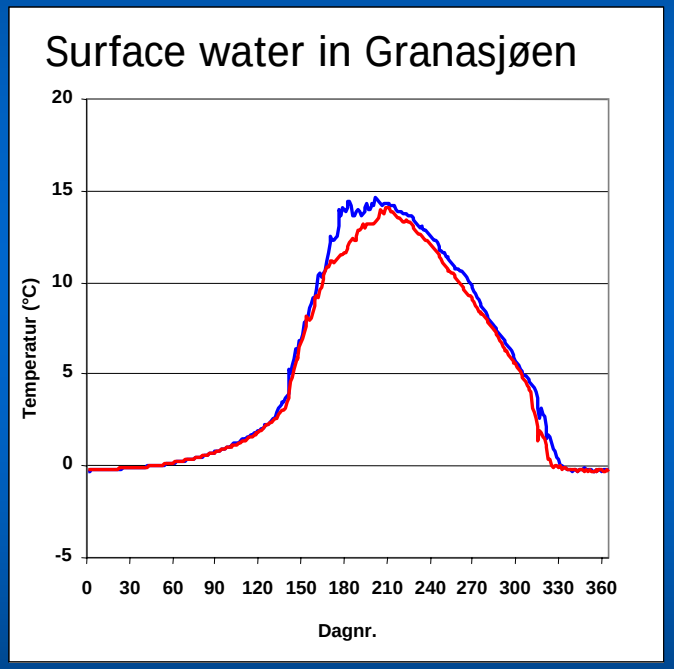


Bypassed water

Income

Vanntemperatur

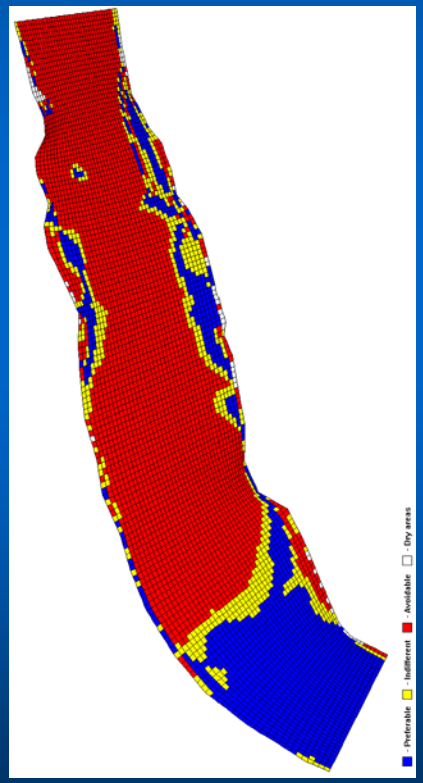


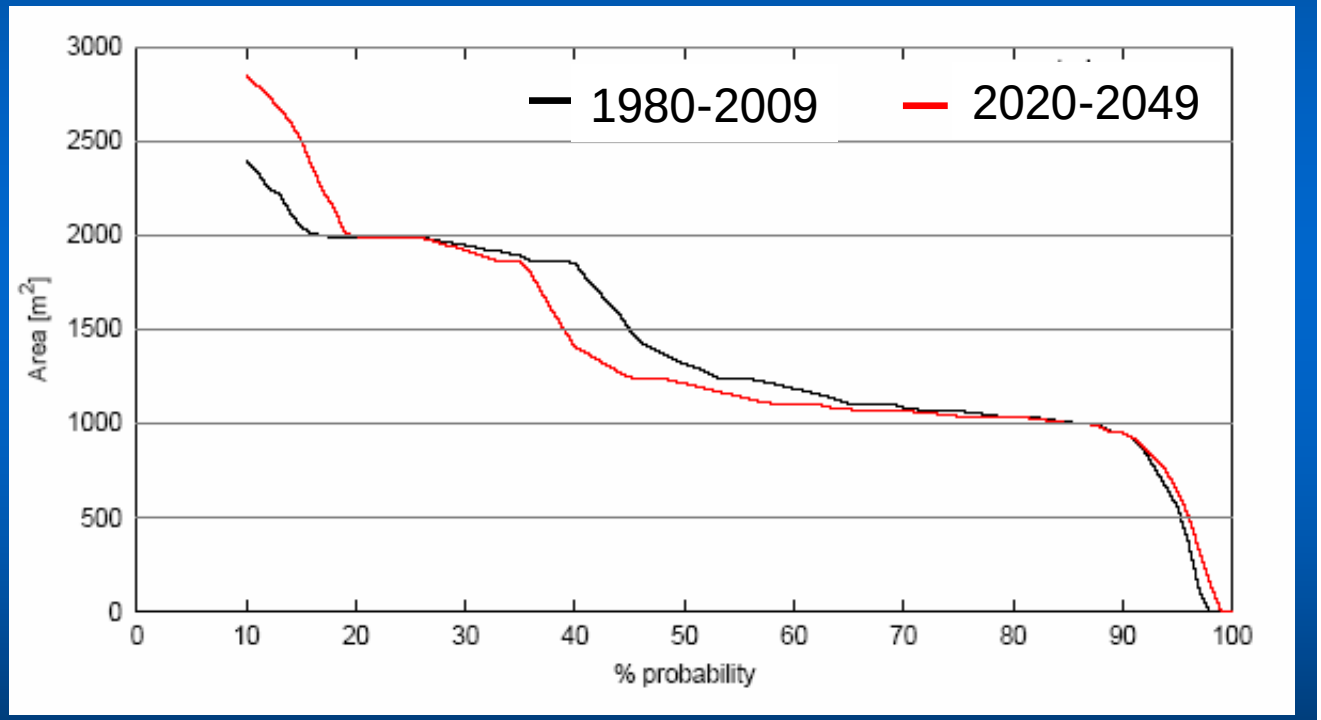


1980-2009

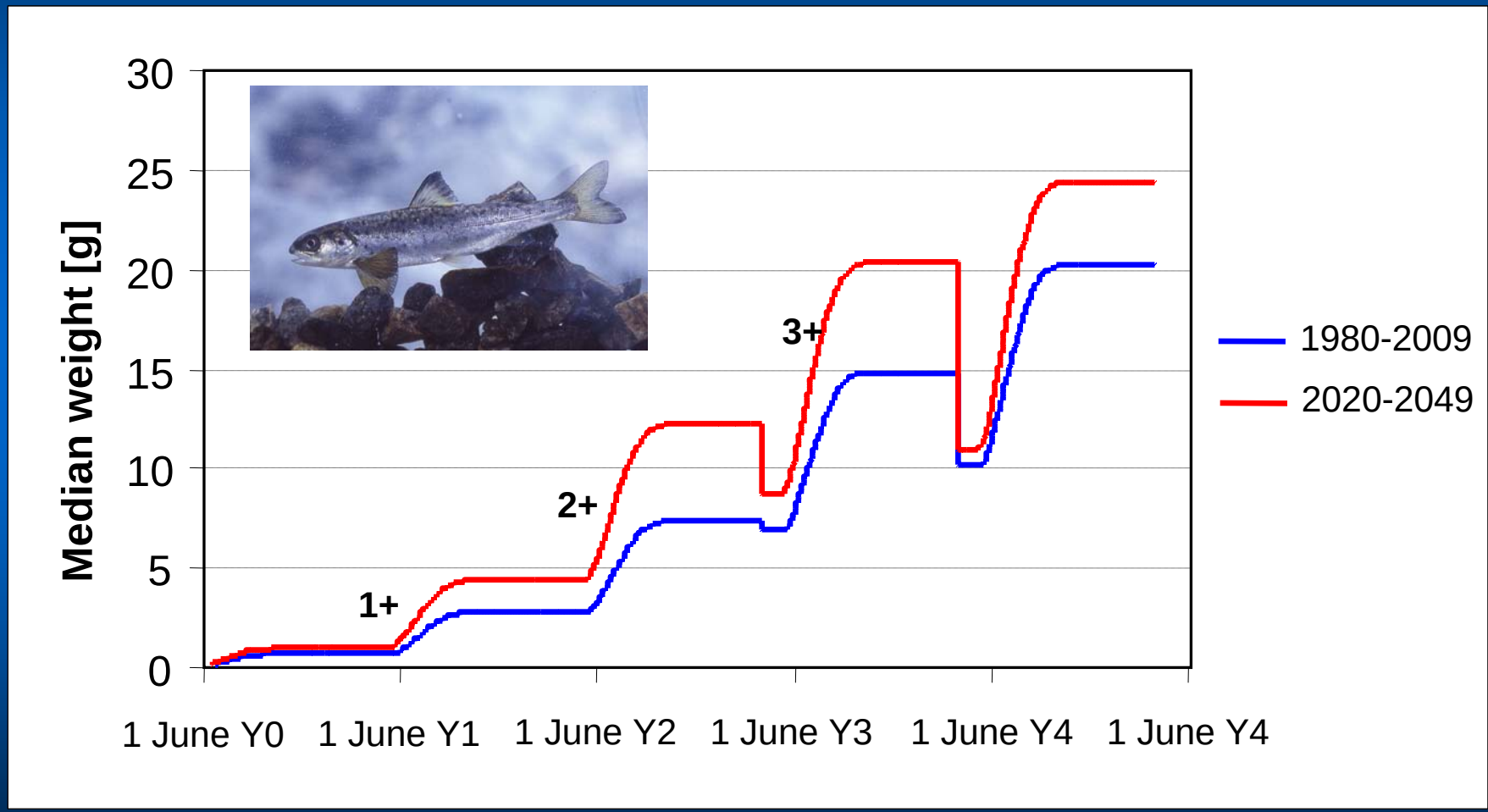
2020-2049

Habitatforhold

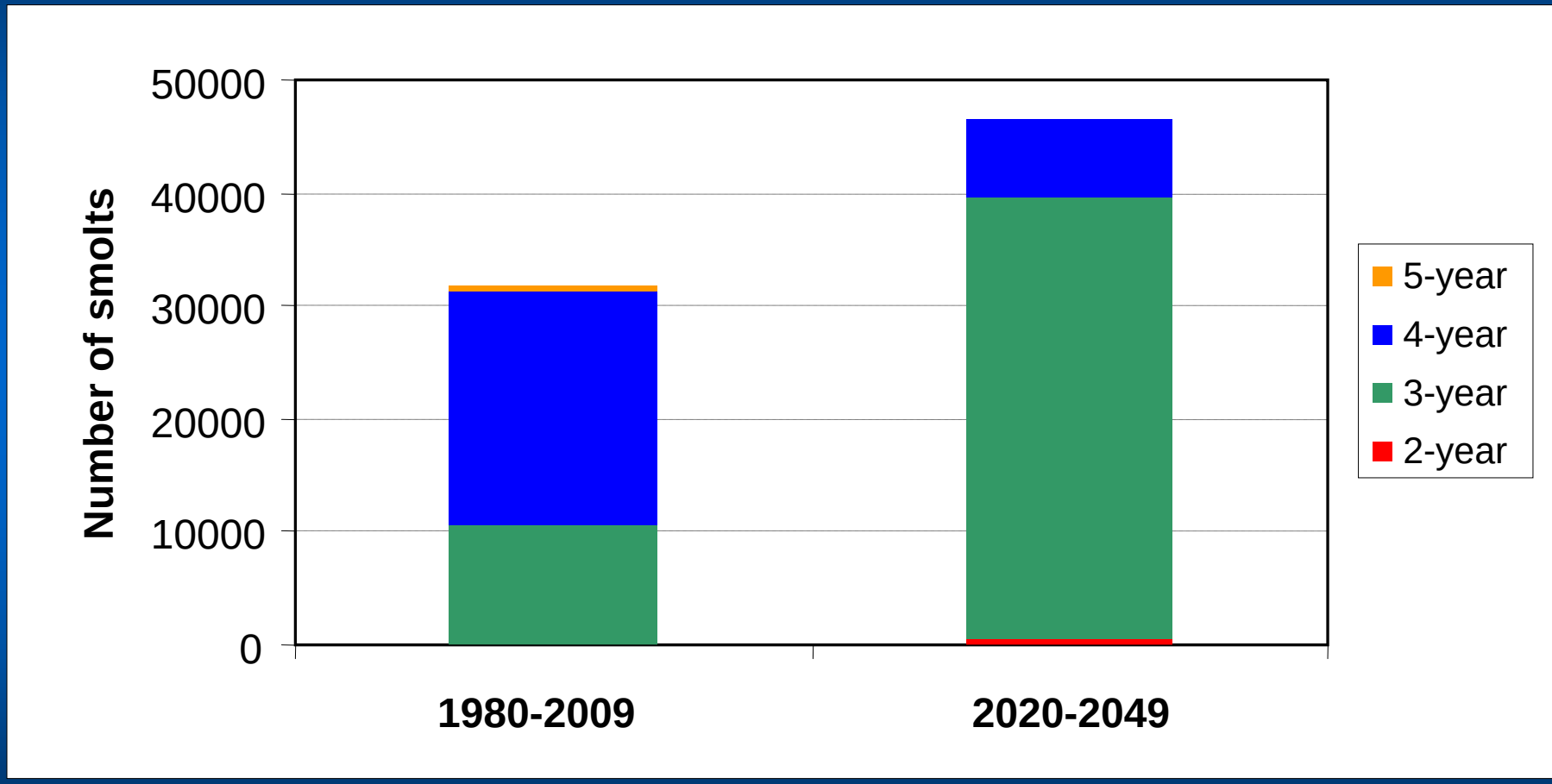




Fiskevekst


Median weight [g]
30
25
20
15
10
5
0
1+
2+
3+
1 June Y0
1 June Y1
1 June Y2
1 June Y3
1 June Y4
1 June Y4
1980-2009
2020-2049

Teoretisk smoltproduksjon

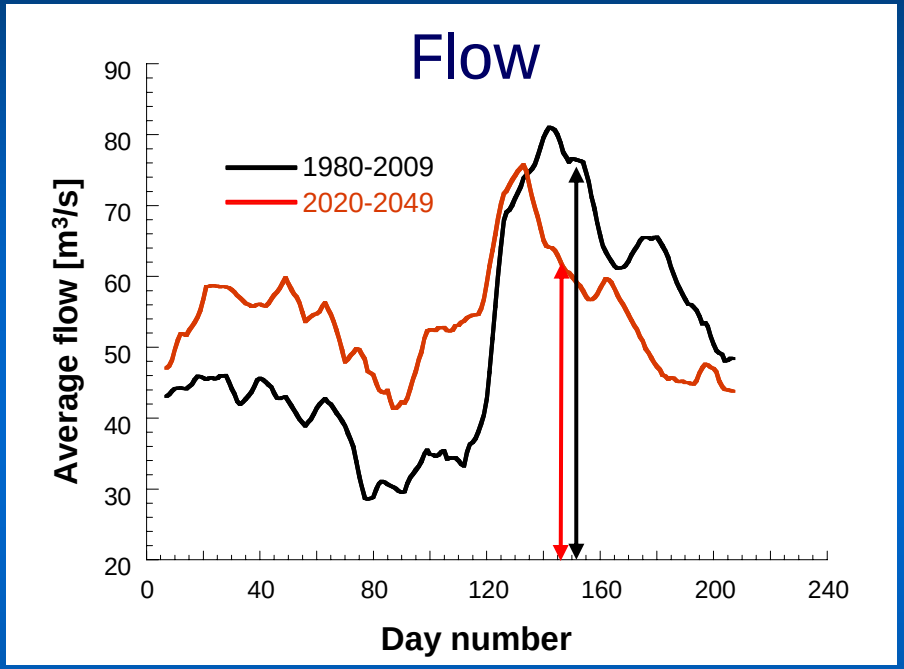


Vinteroverlevelse

- Økt vintervannføring bedrer overlevelse
- Redusert isdekke reduserer overlevelse
- → ingen endring i vinteroverlevelse



Smoltutvandring



11 m^3/s
lavere vannføring

Konklusjoner

- Mer vann og økt kraftproduksjon
- Økt fiskeproduksjon i elva
- Potensiale for å dempe negative effekter i regulerte vassdrag



- **Jeg tror den største utfordringen for norsk klimaeffektforskning er knyttet til metodisk tilnærming**